

# PATENT SPECIFICATION

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## COMPLETE SPECIFICATION

### DRAWINGS ATTACHED

#### Improvements in or relating to Insulated Electric Conductors and Coils Wound therefrom

WE, BRITISH INSULATED CALLENDER'S CABLES LIMITED, a British Company, of Norfolk House, Norfolk Street, London, W.C.2, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an improved form of insulated electric conductor suitable for use in the manufacture of transformer windings and of other electromagnetic coils that require to be impregnated with oil or other insulating liquids. More particularly it relates to a novel form of insulated conductor which can be wound into a multi-turn coil of which the inter-turn dielectric can be readily impregnated with insulating oil or other insulating liquid after the winding of the coil and to transformer windings and other electromagnetic coils, wound from such insulated conductor.

Our novel insulated conductor comprises a ribbon of metal foil having one or each of its major surfaces covered by layers of a porous insulating tissue, for example paper tissue, the innermost of which layers is stuck to the neighbouring face of the foil along a group of two or more mutually spaced lines and each subsequent layer is stuck to its inner neighbouring layer along a group of two or more mutually spaced lines, the mutually spaced lines of adhesion between neighbouring layers of tissue and between the innermost layer of tissue and the foil being so spaced that no lines of adhesion coincide.

Preferably one or each major surface of the ribbon of metal foil is covered by two layers of tissue, the inner layer of which is stuck by adhesive or bonding agent to the neighbouring face of the foil and the outer layer of which is similarly stuck to the

inner layer, in each case along lines spaced as described in the preceding paragraph.

Our invention also comprises a transformer winding or other electromagnetic coil comprising an insulated oil or compound impregnated convolute roll of a ribbon of metal foil having one or each of its major surfaces covered by layers of a porous insulating tissue, the innermost of which layers is stuck to the neighbouring face of the foil and each subsequent layer is stuck to its inner neighbouring layer, along lines of adhesion so spaced that no lines coincide.

The lines of adhesion may turn transversely of the length of the foil but we prefer that they run longitudinally as this not only facilitates the application of lines of adhesive or bonding agent but avoids the need for extreme accuracy in spacing to avoid a creep of one set of lines relative to the other set or sets until thin lines of adhesive between, say, the foil and the innermost layer of tissue coincide with those between two neighbouring layers of tissue. Where the lines of adhesion run longitudinally of the foil the lines may be straight or they may follow a wavy path, for example a sinusoidal path. If desired each of some or all of the lines of adhesion may be built up of a series of unconnected short lengths of adhesive. An insulated conductor in accordance with our invention can readily be wound into a convolute coil in which the successive convolutions are separated by a multi layer of tissue which, since the voltage between them in a coil of a given number of turns is small as compared with the voltage between successive turns of a coil having the same number of turns but wound from narrow conductors in multi-turn layers, can be very thin, for instance, only 0.0005 inch thick.

With such thin tissues the application of

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an adhesive or bonding agent will often result in complete penetration of the tissue, with the consequence that these localised areas cannot be subsequently impregnated and act as barriers to the passage of impregnant through the tissue both from one surface to the other and from one edge towards the other. By using a minimum of two tissues and staggering the areas of application of the adhesive or bonding agent we ensure that even when the lines of adhesion run longitudinally there is in the wound coil always an uninterrupted transverse path for the penetration of impregnant, if not in one tissue then in a neighbouring tissue, the flow path taking a zig-zag or undulating course through a neighbouring pair of tissues to avoid the linearly extending areas of tissue penetrated by the adhesive.

By using two tissues we are also able to keep the insulation thickness to a minimum of say 0.001 inch whilst still reducing to a minimum the risk of an electrical breakdown due to the presence of a metallic occlusion in the paper. This risk can be reduced by using a two-ply or a multiply paper but, since it is not yet a commercial possibility to manufacture two-ply paper having a thickness of 0.001 inch, the insulation will be thicker and consequently the space factor of the wound coil will be lower than is necessary from an electrical stress point of view.

The tissues applied to the foil conductor will be slightly wider than the foil so as to overlap each longitudinal edge of the foil. This will of course reduce the space factor of the wound coil but since the conductor width will be less than the axial length of the coil by only twice this overlap, the coil will have a much higher space factor than that of a conventional coil consisting of multi-turn layers of narrow strip or round wire with dielectric necessarily lying between the successive convolutions of each layer.

The invention will now be more fully described with reference to the accompanying drawing which is a fragmental perspective view of an example of an insulated conductor according to the present invention. In this view the thickness of the various layers of material has been exaggerated to illustrate the invention more clearly.

The conductor comprises a ribbon 1 of copper foil, 6 inches wide and 0.005 inches thick, having one of its major surfaces covered by two layers 2 and 3 of paper tissue, each layer of tissue being 6.25 inches wide and 0.0005 inches thick. The inner layer 2 of tissue is stuck to the neighbouring face of the ribbon 1 by applying to that face along three mutually spaced straight

lines 4 adhesive, such as a suitable resin in liquid or powdered form, each strip of adhesive being about 0.125 inches wide and running approximately parallel to the longitudinal edge of the ribbon. The outer layer 3 of tissue is similarly stuck to the inner layer 2 along four mutually spaced straight lines 5 of adhesive which are of the same width as, and run approximately parallel to, the lines 4 and which are so arranged that no two lines of adhesive coincide. Spacing the lines 4 and 5 of adhesive so that none of the lines coincide ensures that when the insulated conductor is wound into a convolute coil there is always an uninterrupted transverse undulating path 6 through the two layers of tissue for the penetration of impregnant.

#### WHAT WE CLAIM IS:—

1. An insulated conductor suitable for use in the manufacture of transformer windings and of other electromagnetic coils comprising a ribbon of metal foil having one or each of its major surfaces covered by layers of a porous insulating tissue, the innermost of which layers is stuck to the neighbouring face of the foil along a group of two or more mutually spaced lines and each subsequent layer is stuck to its inner neighbouring layer along a group of two or more mutually spaced lines, the mutually spaced lines of adhesion between neighbouring layers of tissue and between the innermost layer of tissue and the foil being so spaced that no lines of adhesion coincide.

2. An insulated conductor suitable for use in the manufacture of transformer windings and of other electromagnetic coils comprising a ribbon of metal foil having one or each of its major surfaces covered by two layers of a porous insulating tissue, the inner of which layers is stuck by an adhesive or bonding agent to the neighbouring face of the foil along a group of two or more mutually spaced lines and the outer of which layers is similarly stuck to the inner layer along a group of two or more mutually spaced lines each of which is spaced from each line of adhesion between the inner layer of the tissue and the foil.

3. An insulated conductor as claimed in Claim 1 or 2, in which the lines of adhesion run longitudinally of the ribbon of foil.

4. An insulated conductor as claimed in Claim 1 or 2, in which the lines of adhesion run transversely of the ribbon of foil.

5. An insulated conductor as claimed in any one of the preceding claims, in which each of some or all of the lines of adhesion is built up of a series of unconnected short lengths of adhesive.

6. A transformer winding or other electromagnetic coil comprising an insulated oil or compound impregnated convolute roll

of a ribbon of metal foil having one or each of its major surfaces covered by layers of a porous insulating tissue, the innermost of which layers is stuck to the neighbouring  
5 face of the foil along a group of two or more mutually spaced lines and each subsequent layer is stuck to its inner neighbouring layer along a group of two or more mutually spaced lines, the mutually spaced  
10 lines of adhesion between neighbouring layers of tissue and between the innermost layer of tissue and the foil being so spaced that no lines of adhesion coincide.  
7. A transformer winding or other  
15 electromagnetic coil comprising an insulated oil or compound impregnated convolute roll of a ribbon of metal foil having one or each of its major surfaces covered by two layers of a porous insulating tissue, the  
20 inner of which layers is stuck by an ad-

hesive or bonding agent to the neighbouring face of the foil along a group of two or more mutually spaced lines and the outer of which layers is similarly stuck to the inner layer along a group of two or more mutually  
25 spaced lines each of which is spaced from each line of adhesion between the inner layer of the tissue and the foil.

8. A transformer winding or other electromagnetic coil comprising an insulated  
30 oil or compound impregnated convolute roll of an insulated conductor as claimed in any one of Claims 3 to 5.

9. An insulated conductor substantially as hereinbefore described with reference to  
35 and as shown in the accompanying drawing.

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1 SHEET

This drawing is a reproduction of  
the Original on a reduced scale.

